Research Article

DECISION MAKING FOR OPTIMAL TREATMENT FOR PATIENTS WITH PERIODONTITIS BASED ON RECENT CLASSIFICATION CRITERIA

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ABSTRACT

Objective: The study aimed to evaluate the accuracy and agreement of clinicians with different education levels and clinical experience in periodontitis diagnosis and treatment planning.

Materials and Methods: Depending on the stage, grade, and extent components of periodontitis, a consensus diagnosis and treatment plan document prepared by two experienced periodontists was used as a gold-standard. An anonymous survey including 10 periodontitis cases was given to 15 participants (5 periodontal experts (PE), 5 postgraduate periodontology students (PS), and 5 undergraduate dental students (DS)) and asked them to classify each case depending on the components of the disease and select their treatment plan from a multiple-choice questionnaire including 11 dental treatment options. The accuracy of the responses was detected by referring to the gold-standard and inter-examiner agreement levels were also assessed.

Results: Except grade, no significant inter-group difference was found in the periodontitis components and this difference only existed in the PE group (p=0.012). PE group gave more accurate treatment planning responses compared to others. The agreement levels of all examiners for stage, grade, and extent were fair (κ=0.366, 0.222, and 0.287, respectively). Treatment planning showed low agreement (κ<0.31) except tooth extraction option (κ=0.554). Both diagnosis and treatment planning responses showed significant variations amongst groups.

Conclusion: Although education level and experience showed superiority in terms of periodontitis diagnosis and treatment planning, the results with low accuracy indicate the need for calibration to reduce the variations and enhance the accuracy.

Keywords: classification, decision making, diagnosis, periodontitis

INTRODUCTION

According to the recent periodontitis classification system (1), periodontitis is diagnosed by using interdental clinical attachment loss (CAL) as the primary criterion, followed by radiographic bone loss (RBL) (2). Once the diagnosis is achieved, the extent, stage, and grade of the disease are also recorded (3) together with the risk and complexity factors to highlight the largeness, severity, and the progression rate of the disease. All these data are used to determine the individual aspects of periodontitis in each case and develop personalized prevention and treatment planning, accordingly (3-6).

Clinical decision-making is a complex process that is influenced by a wide variety of clinical and non-clinical factors such as clinicians' educational level, experience, personal characteristics, daily work overload, and place of initial training (7-9) that create variety in the diagnosis and treatment planning amongst the clinicians. The correct diagnosis of periodontal disease is essential for the initial step of a successful treatment, as erroneous diagnoses may result in either undertreatment, overtreatment, or unnecessary applications.

Concerning the recent periodontitis classification, previous studies reported high variations in accuracy and agreement levels for the diagnosis of periodontitis cases amongst examiners with different educational levels (10-14). Moreover, age, gender, clinical experience, education, faith, socio-economic, and guidelines may affect the decision process causing increased variations between examiners. However, the number of studies investigating the variations between examiners by considering the education level and clinical experience in the use of the recent periodontitis classification in periodontal diagnosis and treatment planning is limited (12, 13). In the light of this information, the study hypothesizes that the variations between students and experts will be high. The purpose of the present study was to evaluate the variations and agreement between final-year dental students, postgraduate periodontology students, and periodontal expert groups in the implementation of the recent classification in periodontitis diagnosis and treatment planning.

MATERIALS AND METHODS

This study was conducted at the Department of Periodontology, Hacettepe University from April to November 2021 and was approved by the Ethical Committee of Hacettepe University, (GO 21/427). All participants were informed about the study and signed the informed consent forms.

Study design and survey

A survey consisting of 10 periodontitis cases was presented to the participants. They were asked to classify each case using stage, grade, and extent and then mark their treatment options. Fifteen participants were selected for the study and equally divided into three groups according to their education level and expertise in periodontology: (i) Periodontal experts (PE) selected amongst certified periodontists, (ii) Postgraduate periodontology students (PS) with three years of clinical experience, and (iii) Final year undergraduate dental students (DS)

Preparation of periodontitis cases

For the questionnaire, two experienced periodontists (N.T and H.G.K) who did not participate in the evaluation selected a total of 10 periodontitis cases based on the recent classification criteria and determined the correct diagnosis and treatment plan responses (gold-standard) using the S3 clinical practice guideline, published by the European Federation of Periodontology (5) (Table S1). The selected cases included various stages and grades of periodontitis excluding other forms of the disease.

Following information was included in the basic records of each case (Table S1): (i) age and gender, (ii) pertinent medical history, systemic diseases, and medication, (iii) smoking (number of cigarettes/ day), (iv) HbA1c values in diabetic patients, (v) dental history (gingival bleeding, tooth mobility, family history of periodontitis, use of interdental oral hygiene devices, parafunctional habits, previous periodontal treatment, the last dental examination and professional oral hygiene procedure (≤1 year, >1 year or >3 years), and the number of tooth loss attributable to periodontitis, (vi) periodontal charting including (1) full-mouth plaque and bleeding scores (FMPS and FMBS), (2) bleeding on probing (BOP; +, -), (3) probing depth (PD) and CAL (recorded at six sites per tooth of the entire dentition), (4) furcation involvement (FI)(15), and (5) mobility (16), and (vii) radiographs (periapical and/or panoramic).

Diagnosis and treatment planning of periodontitis cases

According to the recent classification and treatment guidelines, the cases presented multiple options for diagnosis and treatment plans (5). The diagnosis options for each case were as follows: a) Stage: I / II /III / IV b) Grade: A/ B/ C c) Extent: Localized/ Generalized

Table 1. Accuracy of the diagnosis responses compared to the gold-standard

	DS		PS		PE		Inter-examiner	All examiners	
	correct response	%	correct response	%	correct response	%	p-value	correct response	%
Stage (I-IV)	25/50a	50	33/50a	66	30/50a	60	0.296	88/150a	58.7
I	2/5	40	4/5	80	2/5	40		8/15	53
II	5/10	50	6/10	60	9/10	90		20/30	67
III	10/25	40	17/25	68	13/25	52		40/75	53
IV	8/10	80	6/10	60	6/10	60		17/30	57
Grade (A-C)	19/50**b**	38	27/50a,b	54	34/50a	68	**0.012**	80/150	53.3
A	1/5	20	2/5	40	2/5	40		8/15	53
B	5/15	33	5/15	33	6/15	40		16/45	36
C	13/30	43	20/30	67	26/30	87		59/90	66
Extent	37/50**a**	74	36/50a	72	44/50a	88	0.141	117/150	78

Each subscript letter denotes a subset of group categories whose column proportions do not differ significantly from each other at the .05 level. DS: dental student, PS: postgraduate periodontology students, and PE: periodontal expert

The treatment plan options for the cases were as follows: a) tooth extraction, b) mechanical supragingival plaque/calculus removal, c) subgingival instrumentation, d) repeated subgingival instrumentation, e) resective periodontal surgery for pocket elimination, f) regenerative periodontal surgery for pocket elimination, g) resective periodontal surgery for furcation involvement, h) regenerative periodontal surgery for furcation involvement, i) supportive periodontal care > 6 months, j) supportive periodontal care < 6 months, and k) adjunctive therapies (host modulation, laser/ photodynamic therapy, subgingival antimicrobial, systemic antibiotics).

Statistical analysis

Qualitative data were expressed as numbers and percentages. The inter-examiner level of agreement was evaluated using the Fleiss Kappa statistics. The kappa value coefficient was interpreted according to the criteria proposed by Landis and Koch: less than 0.00 poor agreement, 0.01 to 0.20 slight agreement, 0.21 to 0.40 fair agreement, 0.41 to 0.60 moderate agreement, 0.61 to 0.80 substantial agreement, and 0.81 to 1.00 almost perfect agreement (17). The rates of correct diagnosis between groups were calculated by comparing the column percentages by applying Bonferroni correction. The significance level was set at 5%. The data were analyzed with a statistical software package (IBM SPSS Statistics version 26.0).

RESULTS

Gold-standard diagnosis and treatment plans for each case were given in Table S1. Accordingly, the distribution of periodontitis cases by stage, grade, and extent was as follows: 1 case was defined as stage I (10%), 2 as II (20%), 5 as III (50%), and 2 as IV (20%); 1 was assigned to grade A (10%), 3 to grade B (30%), and 6 to grade C (60%), and 8 were assessed as generalized (80%) and 2 as localized (20%).

Accuracy the diagnosis responses compared to the gold-standard (Table 1)

The majority of the examiners selected the correct stage (58.7%), grade (53.3%), and extent (78%) responses for the periodontitis cases. The correct response rate for the stage component was highest in the PS group (66%), but no significant inter-group difference was found (p=0.296). DS diagnosed the grade component less accurately (38%) than PE and PS (68% and 54%, respectively) and the difference was statistically significant (p=0.012). 88% of PE, 72% of PS, and 74% of DS diagnosed the extent accurately, without any significant intergroup difference.

Table 2. Accuracy of the responses of examiners in case-by-case treatment planning

	Case 1 DS	PS	PE	Overall	Case 2 DS	PS	PE	Overall	Case 3 DS	PS	PE	Overall	Case 4 DS	PS	PE	Overall	Case 5 DS	PS	PE	Overall
Tooth extraction	5	5	5	**15/15**	5	4	5	**14/15**	1	3	5	12/15	1	1	4	6/15	4	5	4	**13/15**
Mechanical supragingival plaque/calculus removal	5	5	5	**15/15**	5	4	5	**14/15**	5	5	5	**15/15**	5	5	5	**15/15**	5	5	5	**15/15**
SRP	5	5	4	**14/15**	5	4	5	**14/15**	5	5	5	**13/15**	5	5	5	**15/15**	5	5	4	**14/15**
Repeated SRP	4	1	2	7/15	2	2	2	6/15	3	2	4	9/15	2	1	4	7/15	2	1	5	8/15
Resective surgery for pocket elimination	2	2	4	8/15	2	2	5	**11/15**	4	5	5	**14/15**	4	5	5	**14/15**	3	4	5	12/15
Regenerative surgery for pocket elimination	1	4	3	8/15	4	5	4	**13/15**	4	0	3	8/15	1	0	5	6/15	4	1	5	10/15
Resective surgery for furcation involvement	4	5	5	**14/15**	0	0	0	0/15	2	2	0	4/15	4	0	4	8/15	4	5	5	**14/15**
Regenerative surgery for furcation involvement	1	5	5	**11/15**	5	2	4	**11/15**	3	0	4	7/15	0	2	5	7/15	1	3	5	9/15
Supportive periodontal care	0	1	0	1/15	0	1	0	1/15	0	3	1	4/15	0	1	1	2/15	0	2	3	5/15
Adjunctive therapies	3	3	4	10/15	4	2	1	7/15	2	3	3	8/15	5	5	4	**14/15**	5	5	4	**14/15**

	Case 6 DS	PS	PE	Overall	Case 7 DS	PS	PE	Overall	Case 8 DS	PS	PE	Overall	Case 9 DS	PS	PE	Overall	Case 10 DS	PS	PE	Overall
Tooth extraction	5	4	5	**15/15**	5	4	5	**14/15**	4	4	4	**11/15**	5	4	5	**14/15**	4	5	4	**13/15**
Mechanical supragingival plaque/calculus removal	5	5	5	**15/15**	5	5	5	**15/15**	5	5	5	**15/15**	5	5	5	**15/15**	5	5	5	**15/15**
SRP	5	4	5	**14/15**	5	5	5	**15/15**	5	5	5	**15/15**	5	5	5	**15/15**	5	5	5	**15/15**
Repeated SRP	3	2	4	9/15	4	3	3	10/15	4	2	3	9/15	4	0	3	8/15	2	1	4	7/15
Resective surgery for pocket elimination	5	5	5	**15/15**	4	5	5	**14/15**	4	4	4	12/15	4	0	5	9/15	5	5	4	**14/15**
Regenerative surgery for pocket elimination	4	4	4	12/15	3	1	0	**13/15**	1	3	4	8/15	2	2	3	7/15	5	4	4	12/15
Resective surgery for furcation involvement	5	5	5	**15/15**	4	4	4	10/15	1	0	4	7/15	4	5	5	**14/15**	4	5	5	**13/15**
Regenerative surgery for furcation involvement	1	5	5	**11/15**	2	2	4	**11/15**	0	2	3	**11/15**	3	2	4	9/15	2	2	5	9/15
Supportive periodontal care	1	2	2	5/15	0	0	0	5/15	2	2	1	4/15	1	1	1	1/15	3	3	2	8/15
Adjunctive therapies	3	3	2	**15/15**	1	3	1	**15/15**	3	2	3	6/15	5	5	4	**14/15**	5	5	4	**14/15**

DS: dental student, PS: postgraduate periodontology students, PE: periodontal expert, and SRP: scaling and root planning. High accuracy rates are shown in bold.

Table 3. Intra and inter-examiner agreement regarding the diagnosis and treatment plan

	DS (n= 5)		PS (n = 5)		PE (n = 5)		Overall (n=15)	
	Kappa	p-value	Kappa	p-value	Kappa	p-value	Kappa	p-value
Diagnosis								
Stage	0.290	<0.001	0.442	<0.001	0.498	<0.001	0.366	<0.001
Grade	0.108	0.089	0.159	0.017	0.4	<0.001	0.222	<0.001
Extent	0	0.5	0.542	<0.001	0.5	<0.001	0.287	<0.001
Treatment plan								
Tooth extraction	0.65	<0.001	0.397	<0.001	0.811	<0.001	0.554	<0.001
Mechanical supragingival plaque/calculus removal	.	.	-0.02	0.581	.	.	-0.007	0.586
Subgingival instrumentation (SRP)	0.053	0.298	-0.111	0.867	-0.064	0.738	-0.002	0.521
Repeated subgingival instrumentation (SRP)	-0.146	0.928	-0.114	0.873	0.064	0.261	-0.047	0.935
Resective periodontal surgery for pocket elimination	0.039	0.35	0.175	0.04	0.548	<0.001	0.255	<0.001
Regenerative periodontal surgery for pocket elimination	-0.011	0.544	0.343	<0.001	0.235	0.009	0.161	<0.001
Resective periodontal surgery for furcation involvement	0.324	0.001	0.323	0.001	0.222	0.013	0.31	<0.001
Regenerative periodontal surgery for furcation involvement	0.035	0.363	0.253	0.006	0.31	0.001	0.073	0.009
Supportive periodontal care >6 month	0.222	0.013	-0.025	0.599	0.324	0.001	0.106	<0.001
Supportive periodontal care <6 month	0.148	0.07	-0.025	0.599	0.324	0.001	0.092	0.002
Adjunctive therapies (Host modulation, Laser/ photodynamic therapy, subgingival antimicrobial, systemic antibiotics)	0.119	0.118	0.066	0.254	0.039	0.35	0.06	0.026

$<$0.00 poor agreement, 0.01 to 0.20 slight agreement, 0.21 to 0.40 fair agreement, 0.41 to 0.60 moderate agreement 0.61 to 0.80 substantial agreement, and 0.81 to 1.00 almost perfect agreement DS: dental student, PS: postgraduate periodontology students, PE: periodontal expert, and SRP: scaling and root planning,

Accuracy of the treatment plan responses compared to gold-standard (Table 2)

The responses regarding the treatment option of tooth extraction, mechanical supragingival, and subgingival instrumentation showed a high rate of accuracy. In contrast, the highest inaccuracy existed in the supportive periodontal care option. Surgical periodontal treatment options showed high or moderate accuracy, particularly with the highest errors in cases 2, 3, 8, and 9. The PE group chose the most accurate responses compared to others. Regarding the furcation treatment option, the highest errors were seen in cases numbers 2,3, and 9.

Agreement of diagnosis across examiners (Table 3)

The agreement levels of all examiners were fair for either stage (κ=0.366), grade (κ=0.222), or extent (κ=0.287) components, respectively. PE showed moderate agreement for stage and extent (κ=0.498 and κ=0.5) and fair agreement for grade (κ=0.4). The agreement level of PS group was moderate for stage and extent (κ=0.442 and κ=0.542), and slight for grade (κ=0.159). DS group showed fair agreement for stage and grade (κ=0.29 and κ=0.108), while showed poor agreement for extent (κ=0).

Agreement of treatment planning across examiners

All examiners showed the highest agreement for tooth extraction (κ=0.554), while there was a poor agreement for all mechanical instrumentation options. Fair levels of agreement were exhibited in resective periodontal surgery option for pocket elimination (κ=0.255) and furcation involvement (κ=0.31). All examiners had slight levels of agreement for the following options: regenerative periodontal surgery (κ=0.161 and κ=0.073), supportive periodontal care (κ=0.106 and κ=0.092), and adjunctive therapy (κ=0.06) (Table 3).

DS group mostly showed low agreement for all treatment options except tooth extraction (κ=0.65). While PS group had a poor agreement level for non-surgical treatment options (mechanical supragingival plaque/calculus removal, subgingival instrumentation, and repeated subgingival instrumentation) and supportive periodontal care and had low consistency for resective and regenerative periodontal surgeries for both pocket elimination and furcation involvement. PE group showed almost a perfect agreement level for tooth extraction (κ=0.811). PE group showed low consistency for the other treatment options

except resective periodontal surgery for pocket elimination (κ=0.548) (Table 3).

DISCUSSION

This study aimed to evaluate the impact of the education level and clinical experience, which are non-clinical factors, on diagnosis and treatment planning of periodontitis cases by referring the recent periodontitis classification. The results demonstrated that final-year dental students, postgraduate periodontology students, and periodontal experts had low to moderate accuracy in diagnosis and low agreement in treatment planning.

Considering the stage, grade, and extent components of periodontitis, the highest accuracy belonged to the extent parameter probably due to its relatively uncomplicated determination method carried out by calculating the rate of affected teeth to whole dentition whereas stage and grade determination requires detailed RBL and CAL measurements as well as the comprehensive evaluation of patient's age, risk factors, tooth loss due to periodontitis that makes their decision-process more complicated and thereby increasing the error rates. The low accuracy levels of DS and PS groups in determining grade levels also supported this phenomenon that shows consistency with the findings of Gandhi et al. (12).

In a similar study, Abou-Arraj et al. (13) gave the diagnostic options to the participants by preparing a questionnaire, not compatible with the clinical reality of the diagnostic process, including only the randomly selected cases diagnosed with various combinations of stage, grade, and extent. Instead, a case list including all response possibilities was preferred in the present study and as result, overall accuracy rates related to stage, grade, and extent were 58.7%, 53.3%, and 78%, respectively. These results were consistent with the stage and extent findings of Ravidà et al. (18) (stage: 68.9%, grade: 73.8%, and extent: 80.7%) and Abrahamian et al. (10) (stage: 68.7%, grade: 82.4%, and extent: 75.5%) and with the extent results of Marini et al. (11) (stage: 76%, grade: 71.4%, extent: 82.6%, and overall: 47.2%). The lower grade and stage scores compared to the relevant literature might be associated with the interindividual evaluation differences (8) owing to the absence of participants with higher expertise in periodontics or without an attendance to any special training prior to the study. On the other hand, the higher accuracy in the extent compared to the stage and grade components of all studies can be attributed to the errors made in the determination of CAL and bone loss that make the diagnostic process multidimensional and complex in the recent periodontitis classification.

It was seen that stage component itself did not show an influence on the accuracy of diagnosis. On the contrary, compared to grade C, a lower accuracy was detected for grades A and B probably due to the obvious characteristics of grade C cases such as high bone loss/age ratio and risk factors, and these findings were in line with Marini et al (11). On the other hand, it was observed that the participants could add the risk factors to the equation with less accuracy in the detection of grade component revealing the need to improve the knowledge and experience of the clinicians by considering the quantitative effect of these factors on the diagnosis.

The S3-level clinical practice guideline recommends that supportive periodontal care visits should be scheduled between 3- and 12-month intervals, and ought to be personalized according to the patient's risk profile and periodontal conditions after active therapy (5). In the present study, the responses regarding to supportive periodontal care showed high inaccuracy. As a possible reason, although guidelines provide advantages in reducing variations, their availability did not guarantee their use possibly due to lack of interest, lack of agreement, lack of involvement, lack of outcome expectancy, lack of time, and fear of restricted professional autonomy (19). Therefore, the importance of supportive periodontal care, which was repeatedly highlighted by guidelines in the decision-making process, should be supported by education and experience. In detail, the present findings may also associated with the relatively novel decision-making process of supportive care by including the risk factors to the determination of grade component (20). On the other hand, the responses regarding to surgical periodontal treatment option generally showed high or moderate accuracy. This may be due to the intensive preference of surgical interventions instead of preventive medicine in the country. However, the error tendency was higher in the selection of regenerative/resective periodontal surgery specifically for cases 2,3,8, and 9. This may be related to erroneous diagnosis and/or lack of knowledge in surgical treatment planning (18).

In general, the agreement on the diagnosis was fair amongst all examiners. While it was lower in dental students (DS), periodontal experts (PE) showed better within-group agreement showing the influence of different education and experience levels to the compliance and variations in diagnosis. Consistent with our findings, Marini et al. (11) reported lower accuracy and inter-rater agreement of DS compared to PE in evaluating the stage and grade components of periodontitis. Similar to diagnosis, PE had a higher agreement in treatment planning compared to other participants and except tooth extraction (moderate

agreement), a poor to fair agreement was detected for all treatment modalities amongst the participants. These findings were in line with the relevant studies (12, 21, 22) and might indicate the lack of calibration, education, experience, and up-to-date information amongst the participants showing the necessity of advancement in the training and experience of the participants.

CONCLUSION

Limitations of this study were the small number of examiners and periodontitis cases. Within these limitations, the present findings showed that except the extent component, clinicians still cannot reach a high level of accuracy in periodontitis diagnosis referring to the recent periodontitis classification. Moreover, different education levels and clinical experience that caused high variations do not affect the accuracy of the decision for stage and extent but the grade which seems much more complicated and inconsistent amongst the clinicians. In terms of treatment planning, education level and experience provide differences in making decisions about phase I therapy, tooth extraction and supportive periodontal care. However, on the whole, the results with low accuracy show that the classification could not be implemented to various clinical scenarios and the education level and clinical experience lead to variations in clinical practice. To reduce the variations and enhance the levels of accuracy in classifying and planning the treatment of periodontitis cases, encouraging the use of guidelines and supporting clinical experience with supportive training can be recommended.

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Authorship contributions
Ceren Kütük: Data collection, literature search. Hanife Merva Parlak: Literature search, writing. Ayhan Parmaksız: Analysis. Nermin Tarhan: Concept, design, writing.H. Gencay Keçeli: Concept, design, writing

Data availibity statement
The data are available from the corresponding author.

Declaration of competing interest
The authors report no conflicts of interest related to this study.

Ethics
Permission was obtained from the Ethics Committee of Hacettepe University (GO 21/427) for the study protocol. All participants were informed about the study and signed the informed consent forms.

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